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The Telidon Road/Weather Information System (RWIS): User Evaluation During 1986-1987 Winter Trial

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The Telidon Road/Weather Information System (RWIS): User Evaluation During 1986-1987 Winter Trial

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Abstract:	This report describes the results of the second winter trial (1986-87) of RWIS. The evaluation assesses RWIS from the user's perspective, and makes recommendations about future development, implementation, and training. Four main conclusions were drawn. Firstly, RWIS is easy to use and to learn to use. Quality user documentation and training support have been developed; however, much of the information is meteorological data the interpretation of which requires some training. Secondly, RWIS has no major impacts on organizational or personnel matters, and those impacts it has (e.g., increase in job interest) are generally positive. Thirdly, RWIS permits users to make better-informed operations decisions, although it is no replacement for experience and good judgement. Fourthly, the cost-effectiveness benefits of RWIS appear to come from improved decision-making and improved service to the public rather than from impacts on specific operations. Patrol personnel were by far the heaviest usersof RWIS, and short-term weather forecasting was the most-used function. RWIS was found to be suited to usage by individuals rather than as a primary information source for mass distribution services. Most users had positive attitudes to RWIS; however, some preferred to be able to react spontaneously to winter operations demands. Therefore, large-scale implementation of RWIS would require careful organizational planning.
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1.0 EXECUTIVE SUMMARY

This report describes the results of the second winter trial of the Telidon Road/Weather Information System (RWIS). The RWIS system is a computer based service that distributes information about road and weather conditions to Ministry of Transportation and Communications' (MTC) personnel in public information and maintenance operations services. The purpose of the evaluation was to evaluate RWIS from the user's perspective, and to make recommendations about future development, implementation, and training.

The second winter trial was conducted during the 1986-1987 winter season. It was an extension of the first winter trial of RWIS (Engel and Townsend, 1986) which began late in the 1985-1986 winter season. In the first winter trial, users did not get enough opportunity to work with RWIS to form considered opinions about the usefulness of RWIS. Thus, the second winter trial was designed to complete the evaluation program begun in the first winter trial.

1.1 Conclusions from the Second Winter Trial

We drew four main conclusions from the results of the trial. Briefly, they are;

1) Ease of Use RWIS is easy to use, and easy to learn to use. Except for some minor design faults, the system is convenient for both regular and occasional users. The user documentation is more than adequate, and there is well designed and economical training support for new users.

2) Organizational Impacts RWIS has no major impacts on organizational or personnel matters; and what impacts it has are generally positive. The system does not substantially affect work methods or organization. For most individual users, RWIS provides some increase in job interest, and an opportunity to acquire experience with new technology.

3) Utility From users' opinions, and their patterns of system usage, users, particularly at patrols, find that RWIS provides weather information that is useful for managing winter operations. However, few users were able to specify exactly what roles RWIS information played in operations management. Access to RWIS permits users to make better informed operations decisions, but not to the degree that RWIS replaces the traditional roles that experience and good judgment still play in maintenance operations decision making.

4) Cost-Effectiveness Although direct measurement of RWIS cost-effectiveness was beyond the scope of this study, users were asked to identify possible sources of benefits. The cost-effectiveness benefits of RWIS, appear to come from generally improved decision making, and improved service to the public rather than from impacts on specific operations. The cost of RWIS could be reduced if RWIS were operated on microcomputer terminals which could also be used for office automation applications that were identified in most of the users' operations. We concluded that it would be worth exploring operating RWIS on microcomputer terminals that would also support office applications.

5) Attitudes to RWIS Most users had positive attitudes to RWIS. However, some maintenance users had somewhat negative reactions to RWIS. These tended to be users who rely on being able to react quickly to winter operations demands whenever necessary. The fact that reactions to RWIS were not unanimously positive means that any implementation of RWIS would still require careful organizational planning.

In the remainder of this summary, we will briefly review the evaluation procedures and findings, and the reasons for our conclusions.

1.2 Description of RWIS

RWIS is a Videotex information system. It is maintained on a central computer, and users gain access to the system from remote terminals that are connected to the computer through conventional telephone lines. A terminal gives the user access to a number of information functions. Six functions contain information about current weather conditions; five functions contain weather forecast information; and four functions contain information about road conditions. There is also a function that can be used by patrols to enter their road and weather reports.

The RWIS terminal video display unit presents information by means of coloured text and graphics displays. RWIS displays are designed to be self-explanatory. Weather information includes weather maps, weather radar displays, and ordinary text displays. The road information includes maps of District highways, colour coded to represent road conditions, maintenance operations in progress, and driving conditions. Most RWIS commands can be performed by making menu selections or by typing keyword commands on a keyboard.

RWIS information comes from two main sources. The Atmospheric Environment Service supplies weather information; and MTC District Maintenance patrols supply road information. One of the RWIS functions is an input function that can be used by MTC personnel to enter road and weather information into the RWIS computer. The RWIS data base is available 24 hours a day, and is amended at intervals varying from every 10 minutes to every 24

hours depending on the type of information being amended.

1.3 Design of the Evaluation

RWIS was installed for testing in Districts 6 (Toronto), 8 (Kingston), 9 (Ottawa), and 10 (Bancroft) beginning in February, 1986. Terminals were also installed in the Road Information Office (RIO), and in York Region. However, the evaluation being reported here was conducted only in District 6 and in the RIO. For the first winter trial in District 6, terminals were installed in the District Office, and the Radio Room. Based on findings from the first winter trial, terminals were also installed in three District 6 patrols for the second winter trial.

For the purposes of the evaluation, RWIS users included District 6 maintenance operations management personnel, maintenance patrol personnel, Radio Room personnel, and RIO personnel. The aims of the evaluation were to assess the ease of use of RWIS, and to find out how users could apply RWIS services in their jobs. The evaluation method contained five components designed to achieve these aims. The components were:

1) a task analysis of the users' jobs to determine what job tasks would be affected by the use of RWIS;

2) a human factors assessment of the RWIS user interface;

3) a critical incident analysis, which amounted to doing an analysis of the potential for using RWIS in managing operations in response to winter storms;

4) monitoring of the operations management and control systems that were expected to be affected by RWIS; and

5) a user opinion survey to be conducted at the end of the trial.

Evaluation activities in the first winter trial were concentrated on the first three components. In the second winter trial, we brought findings from the first winter up to date, and then concentrated on completing the operations monitoring and the opinion survey activities.

1.4 Results

Both the user task analysis and the critical incident analysis showed that the primary application of RWIS services was in the management of winter maintenance operations at the level of individual patrols. Almost all of the outcomes of maintenance operations decision making are affected by weather conditions.

The RIO's major function is to distribute information to mass media. Although RWIS provides a convenient way for an individual to get information about road conditions, it is not particularly suited to be a primary information source for the mass distribution services as currently provided by the public information personnel. In addition, RWIS does not provide much road information that is not already available in existing reporting systems. Although RIO personnel appreciated the convenience of RWIS, public information applications of RWIS would depend on the RIO's clients having direct access to RWIS.

The review of the RWIS user interface showed that the system was generally well designed, and easy to use. A number of specific design improvements were identified, for the most part, these improvements concerned design inconsistencies, and system characteristics that interfered with the user's ability to absorb information from the displays. In addition, good quality user documentation and training support was developed for use in the second winter trial.

Although the RWIS is easy to use, much of the information is meteorological data that normally only people who have some training in meteorology can interpret and use. The training support materials provide a good introduction to meteorology; but for RWIS to be used effectively, the patrol users will still need to be given continuing training in meteorology.

Statistics on RWIS usage showed that patrol personnel were by far the heaviest users of RWIS. Each patrol accessed RWIS an average of about 15 times a day. Accesses were spread fairly evenly around the clock. The RWIS functions that provide information for short-term weather forecasting were the most heavily used of all the RWIS functions. There were consistent substantial correlations between volumes of RWIS usage and occurrences of bad weather. This suggested that users did indeed find RWIS useful for aiding in maintenance operations management.

Most users liked using RWIS. Although most users had no prior computer experience, all found RWIS easy to learn, and convenient to use. Although installation of RWIS had no significant organizational impacts, or personnel impacts, using the system provided some modest job enrichment benefits.

Consistent with the usage statistics, most users thought that their operations benefitted as a result of having access to RWIS. However, even users with strongly favorable opinions about RWIS found it difficult to articulate just how RWIS made operations more efficient or more effective. For most winter maintenance operations, decision making consists of decisions made by applying experience and judgment in a context of incomplete information. RWIS appears to make the decision making information less incomplete than before, but it does not change the nature of the decision making process.

Related, we believe, to the nature of operations decision making, some users had negative responses to RWIS. For some users, or potential users, quick reaction to almost any weather situation is the main operations management strategy. Such users place little reliance on weather forecasting; and consequently, have little use for RWIS. Indeed, for these users, incorporating RWIS into operations decision making would mean more than making use of an additional information source. It would mean a change in approach to operations management; and for some, it would mean an implicit threat to an established management style. Thus, although RWIS is mechanically easy to adapt to, any larger scale implementation would still require the same careful organizational planning that is required for implementing any other system.

The Telidon Road/Weather Information System (RWIS)
User Evaluation During 1986-1987 Winter Trial

2.0 INTRODUCTION

This report describes the user evaluation results for the second winter trial of the Telidon Road/Weather Information System (RWIS). This Telidon service distributes information about road and weather conditions to personnel in road maintenance and public information services of the Ministry of Transportation and Communications (MTC). The RWIS system was installed for testing and evaluation late in the 1985-1986 winter season. The purpose of the user evaluation was to assess the usefulness of RWIS from the user's perspective, and to make recommendations about future development, implementation, and training support.

A previous report (Engel and Townsend, 1986) on the first winter trial contains background information about how RWIS works, descriptions of the users' operations, and early findings from the user evaluation. This report of the second winter trial concentrates on evaluations from users after a full winter season of experience with RWIS.

The report of the second winter trial will begin with a brief review of the results of the first winter trial (Engel and Townsend, 1986). Next we will describe the methods that were used to gather the user evaluation data for the second winter trial. Then we will describe the results of analyses of the evaluation data. Finally, we will present the evaluation conclusions and recommendations.

3.0 DESCRIPTION OF RWIS AND THE STRUCTURE OF THE RWIS TRIAL

In the first part of this section, we will briefly review the operation of RWIS, including changes that were made in RWIS between the first and second winter trials. Then we will describe the organization of the trial, again including changes in organization that occurred between the first and second winter trials.

Next, we will review the first winter trial in enough detail to let readers absorb this report without first having to read the previous report of the first winter trial. In the final part of this section, we will describe the main conclusions from the first winter trial, and what impacts these conclusions had on the evaluation activities for the second winter trial.

3.1 RWIS System Description

RWIS is a Videotex information system that distributes road and weather information mainly to users in road maintenance operations and public information services. For readers who are not familiar with RWIS, Appendix A contains a description of the system. Except for a number of system enhancements made since the first winter trial, Appendix A describes essentially the same system that was installed for the first winter trial.

The most significant system enhancements since the first winter trial consisted of additions of summary weather radar pages, a system function to be used by patrols for submitting patrol road and weather reports, an operational help function, and an on-line user training program. In addition, numerous minor improvements were made in the designs of the original functions that were available during the first winter trial.

3.2 Structure of the Evaluation Trial

For the first winter trial, RWIS was installed in four MTC Districts; District 6 (Toronto), District 8 (Kingston), District 9 (Ottawa), and District 10 (Bancroft). Our evaluation activities were conducted only in District 6. For District 6, two RWIS terminals were installed; one in the District Radio Room, and one in the District 6 Headquarters. In addition, a terminal was installed in the MTC Road Information Office (RIO).

Users in District 6 first began using RWIS in February, 1986. The District 6 Radio Room received one of the first terminals. The RIO did not receive a terminal until late March, 1986. Because of the timing of the system installation, the evaluation activities in the first winter trial were aimed primarily at gathering background information about users' operations. As a result of reviewing operations, we recommended that RWIS terminals should be installed in some patrols so that the impact of providing patrols with direct access to RWIS could be assessed. Thus, for the second winter trial, three patrols in District 6 were provided with RWIS terminals; and these patrols were added to the user evaluation.

4.0 EVALUATION METHOD

We will describe the overall evaluation plan, and then describe what portions of the plan were completed during the first winter trial, and what portions were left to be completed in the second winter trial. The evaluation design contained five components:

1) task analyses of the user's jobs to determine what job tasks would be affected by the use of RWIS;

2) a human factors assessment of RWIS;

3) critical incident analyses of the use of RWIS;

4) monitoring of the operations management and control systems that were expected to be affected by RWIS; and

5) a user opinion survey.

We will briefly describe each evaluation task in turn. More detailed descriptions of the evaluation components are given in the report for the first winter trial.

4.1 User Task Analysis

The task analysis was done to produce descriptions of users' job functions, particularly functions that would be affected by the use of RWIS. The task analysis was done from information obtained in personal interviews supplemented by information from the users' official job descriptions. Users were defined as personnel whose operational responsibilities would be significantly affected by the use of RWIS. These included personnel who had direct access to RWIS terminals, operating personnel whose day-to-day tasks could be affected by information acquired from RWIS, and management or supervisory personnel whose operations could be affected by how subordinates used RWIS.

4.2 Human Factors Assessment of RWIS

The purpose of the human factors assessment was to evaluate ease of use of RWIS, both from the perspective of the user operating an RWIS terminal, and from the perspective of an indirect user whose operations could be affected by the use of RWIS. For reviewing the operator interface we reviewed the system operating and training documentation, and the operation of each of the system functions. We then compared the terminal documentation and operating procedures with published design guidelines (Smith and Aucella, 1983; Engel and Granda, 1975; Ramsey, Atwood, and Kirshbaum, 1978; Badre and

Shneiderman, 1982; and Kantowitz and Buck, 1983).

For evaluating how indirect users were affected by RWIS, we developed flowcharts of the routings of RWIS information going from the direct users to the indirect users. In combination with data from the task analyses, the charts were used to identify ways in which indirect users could make effective use of RWIS information.

4.3 Critical Incident Analysis

Critical incident analysis is a commonly used technique for analyzing job activities that are episodic in nature; for example, the activity of a bank teller processing a customer's transaction. For RWIS, we treated the set of maintenance operations that represent the response to a winter storm as a critical incident where RWIS would be expected to play a significant role in maintenance decision making, and in providing the public with information about road conditions. The critical incident analysis was to be conducted by observing operations during a winter storm, and through debriefing sessions to be conducted after the storm. As it turned out, it was more convenient to obtain the critical incident data as part of the task analysis because most operating personnel tended to describe their job functions in terms of responses to storms.

4.4 Monitoring of Impacts

This evaluation component was to consist of collecting RWIS usage statistics, and any management information statistics that might be expected to show effects due to the use of RWIS. In addition, provision was made for keeping in touch with selected users who could keep us informed about any day-to-day events that might affect system usage or the evaluation findings.

4.5 User Opinion Survey

The User Opinion Survey was to be conducted at the end of the evaluation after the users had gained substantial experience with RWIS. The survey's purpose was to provide information about users' opinions on specific evaluation issues such as RWIS convenience, impacts on personnel matters, and impacts on operations effectiveness.

4.6 Evaluation Components Completed in First Winter Trial

During the first winter trial, we completed the first three components of the user evaluation: the user task analysis, the RWIS human factors assessment, and the critical incident analysis. The remaining two components, monitoring of operations, and the user opinion survey were completed during the second winter trial.

4.7 Results of the First Winter Trial

Results from the user task analysis and the critical incident analysis showed that RWIS provided weather information that was directly relevant to operations decision making at patrols. Most of the outcomes of the patrol supervisor's decisions depended on how accurately the supervisor anticipated weather conditions, particularly before and during a storm. Because day-to-day maintenance operations are controlled at the patrol level, management personnel above the patrol level use weather information as part of keeping an overview of the general situation rather than as a means of directly controlling patrol operations.

The public information services' major functions are to distribute information to mass media. Although RWIS provided a convenient way for an

individual to get information about road and weather conditions, it was not particularly suited to be a primary information source for the mass distribution services provided by the public information personnel. In addition, RWIS did not provide much information that was not available from already existing reporting systems. However, in the first winter trial, RWIS was installed in the RIO for only a very short time before the end of winter. Therefore, the RIO users had very iittle opportunity to see how RWIS might eventually fit into their operations.

The review of the RWIS user interface showed that the system was generally well designed, and easy to use. However, numerous minor design improvements were identified. For the most part, the improvements concerned inconsistencies and system characteristics that inconvenienced the user, or made it unnecessarily difficult to interpret some of the RWIS displays. There was also no user documentation available when the terminals were installed.

Although the RWIS was easy to use, much of the information provided by RWIS is meteoroiogical data that normally only people who have some training in meteorology can interpret and use. Generally, the users did not have such training. Consequently, we recommended that users be given training on how to interpret the weather information that RWIS provided.

The organization of maintenance operations showed that there were no efficient procedures that would give patrol personnel meaningful access to RWIS information. Patrol personnel could only get RWIS information by having someone in either the Radio Room or the District Office relay the information by radio. In our view, it was not realistic to expect to distribute useful RWIS information in this way. For this reason, we explored the possibility of having RWIS terminals installed at a sample of patrols.

To assess the value of having RWIS at patrols, we performed a preliminary capital investment analysis to see if the cost of RWIS operation could potentially justify patroi level installations. The analysis showed that RWIS could be cost justified if the average patrol could save about 1000

dollars a month during winter operations by having access to RWIS. Since the required saving was small relative to the average patrol's budget, we recommended conducting a test with RWIS installations in patrols.

To summarize the results of the first winter trial, the evaluation activities provided basic information about the nature and organization of the users' operations, an assessment of the RWIS terminal user interface, and some preliminary findings about the usefulness of RWIS in users' operations. Because of the short time that users had for getting experience in working with RWIS, it was not possible to produce any definitive findings about operational impacts of RWIS. Consequently, MTC management decided to extend the RWIS trial into the 1986-1987 winter.

4.8 Evaluation Activities in the Second Winter Trial

The evaluation in the second winter trial consisted mainly of completing two components of the evaluation method that remained to be done after the first winter: monitoring of the operations management and control systems that were expected to be affected by RWIS, and conducting the user opinion survey. In addition, we reviewed and updated the task analysis, human factors, and critical incident findings from the first winter trial so that the final evaluation results would reflect the users' operational situations at the end of the second winter trial.

To test the effects of RWIS installations at patrols, terminals were installed in three test patrols selected by District 6 management. Two of the test patrols were freeway patrols, and one was a rural patrol. The rural patrol and one of the freeway patrols had terminals installed by 1 December, 1986, so both of these patrols had access to RWIS for almost the entire winter season. The other freeway patrol did not receive a terminal until 29 January, 1987.

The data gathering procedure for the second winter trial amounted to performing four main activities. In December, we conducted a round of interviews with all of the District 6 users. These interviews were designed to re-introduce the evaluation study to the users, and to bring us up to date on any changes in the users' operations that had occurred since the first winter trial. We then commenced identifying sources of operations monitoring data that could be used to quantitatively assess the effects of having RWIS. Acquisition of these monitoring data continued throughout the winter. After getting the monitoring data collection under way, we conducted a review of the RWIS user interface to bring our previous user interface assessment findings up to date. Finally, at the end of the winter season, we conducted the user opinion survey.

5.0 RESULTS

We will describe the results by reference to the five evaluation tasks that made up the components of the evaluation method. For the user task analysis, the RWIS interface assessment, and the critical incident analysis, we will only report results that reflect changes from the results reported for the first winter trial.

5.1 User Task Analysis

There were no major changes in the user organization, or in the users' operational responsibilities since the first winter trial. However, the three patrols that received RWIS terminals did get one additional responsibility. In early February, a patrol road and weather reporting program was implemented on RWIS so that these patrols could submit their five-times-a-day road and weather reports by entering them into the RWIS terminal. While this new task did not represent a major change in patrol workload, it did create 10 to 15 minutes of extra work for each report that the patrol submitted.

5.2 Human Factors Assessment

In this section we will bring update the interface review done in connection with the first winter trial, and as a new consideration for the second winter, review a user training program that was developed to introduce patrol personnel to RWIS.

5.2.1 User Interface Review

The user interface review was conducted by systematically going through the system pages over the course of several sessions on a regular RWIS terminal. In addition, we had periodic access to RWIS by means of a Telidon program operating on a microcomputer. Although the RWIS system design remained very similar to what it was for the first winter trial, some new information functions were added for the second winter trial; and numerous improvements were made in the individual designs of the original information functions.

The RWIS terminal equipment consists of reliable high quality components. The colour monitor produces a clear display with good colour fidelity; and the console keyboard is easy to use. The monochrome electrostatic printer is adequate for recording text information, and for recording at least rough black and white copies of graphics. Although none of the users had a critical need to regularly print copies of the RWIS displays, most said that they would prefer to have a colour printer. In our opinion, most users could get along without the printers. Instead, a printer, possibly a colour printer, could be installed in a central location where display copies could be made at the user's request.

In general, users, including users with no prior computer experience, have found RWIS easy to learn to use, and easy to use in day-to-day operations. All of the information in RWIS can be retrieved by means of menu

commands; and most of the displays are self-explanatory. Since the first winter trial, a number of improvements were made to make system pages easier to comprehend.

From the second winter trial interface review we found several additional design improvements that could be made. Details of the improvements are described in Appendix B. The appendix describes some general improvements for the display of date and time information; improvements in providing users with operating prompts; and improvements in the use of keyword commands. In addition, the appendix contains suggestions for improving the design of certain individual RWIS pages.

Except for improvements to the Road Report program, none of the suggested design improvements are critical. Improvements in the Road Report program would eliminate some significant inconveniences, and make the program substantially easier for patrol personnel to use.

5.2.3 User Manual

In the report of the user evaluation for the first winter trial, we reviewed a draft of a user manual. A glossy 5.5" by 8" Cirlux bound version of the manual was issued before the second winter trial.

The manual is concise and easy to use. It shows how to set up the terminal, and describes the operations of the different RWIS functions. It also gives a variety of reference information such as the times when RWIS weather information functions are up-dated, lists of keyword commands, and the translations of identifier codes for weather stations.

The only addition that might be considered for the manual is a section on what the user should do if he or she cannot make a communications connection with the RWIS computer. During the trial, users found that the telephone number given as the number to call in case of trouble was answered only during normal working hours. During other hours, the user would have to

call another user in MTC for suggestions on solving a problem with the terminal. It would be helpful if the manual contained a section on diagnosing and curing common communications problems.

In fact, since the on-line help function contains the same operating instructions as the manual, the contents of the manual could be reduced to providing instructions on setting up the terminal, and on what to do in case of communications problems. We found that because of the general ease of use of RWIS, users seldom needed to refer to the manual; and many would be pressed to remember where they had filed the manual.

5.2.4 Training

In the report of the first winter trial we observed that while the mechanics of operating RWIS made RWIS easy to use, most of the weather information provided by RWIS is in the form of meteorological data that requires some meteorological sophistication to interpret. In fact, much of the RWIS weather information is more technical than the average user could be expected to understand without having some specific training in meteorology. Just before the beginning of the second winter trial, a training package was developed to provide meteorological training, and to provide instruction on how to operate RWIS. In this section, we will review the effectiveness of the training package.

The training package consisted of two components; a workbook called the "RWIS Self-Instructional Workbook", and an on-line training module that could be accessed on an RWIS terminal. The training module is briefly described in the system description in Appendix A. The training package also contained a reference card that could be displayed beside a terminal. In addition to the training materials, a half-day training workshop was created to provide an introduction to the training package.

The training was given to personnel in the three patrols that received RWIS terminals. None of the other users were given the training package.

Half-day introductory training workshops were conducted at the end of January, and the beginning of February. This was two months after two of the patrols had received their terminals, but almost on the same day as the terminal was installed in the third patrol. Thus for two of the patrols, the training was given well after the patrol personnel were already regularly using RWIS.

The training workshop was designed to introduce the primary training materials; the self-instruction workbook, and the on-line training module. After the workshop, trainees were to work through the workbook while signed onto the on-line training module on the RWIS terminal. The workbook was designed as a programmed learning workbook in which the trainee studies a short section of the workbook, and then answers questions on the section that was just studied. While working through the workbook, the trainee would also be instructed to retrieve display pages from the on-line training module to see illustrations of points being covered in the workbook. Thus, for example, the section of the workbook that explains weather, prompts the trainee to call up pages from the on-line training module that show various features of the RWIS General Weather pages. In the process, the trainee learned about interpreting weather maps in general, and about interpreting the types of weather maps shown in RWIS. All of the patrol personnel completed the self instruction program at their own pace, and at times when the patrol's terminal was available.

We evaluated the training package using information from three main sources; comments made by patrol personnel during the user evaluation interviews; from observations that we made during participation in one of the training sessions, and from observing a post-training feedback discussion in which all trainees participated about three weeks after the training sessions were completed. The feedback session was organized and conducted by the developers of the training package.

The training package was found to be generally well designed; and trainees found it to be convenient and useful. Indeed in the feedback discussion, it was difficult to get the trainees to focus on providing

critical feedback about the training package. Instead of discussing the training, the trainees kept focusing on issues associated with applying RWIS in their jobs rather than on the merits of the training package. The trainees were generally happy with the training package, so they did not have many training issues to discuss.

The trainees' experience with the training package yielded suggestions for only minor improvements in the training. These suggested improvements are described in Appendix C. The only area where the training needs to be improved is in instruction on interpreting the radar images. Although the training package covers radar quite adequately relative to the goals of the training program, it appears that patrol personnel still need more intensive training on interpreting radar images.

Many users complained that the radar was often unreliable. From technical information supplied to us by AES, it is indeed true that the radar can be unreliable because of the effects of different atmospheric conditions on radar signals. For example, refraction of the radar signal caused by certain atmospheric conditions can produce false echoes; for example, echoes from objects on the ground. At present, patrol personnel do not have enough depth of knowledge about weather radar to be able to take account of conditions that affect the fidelity with which the radar shows precipitation patterns. With more concentrated training, they would be better able to wisely interpret the radar information.

5.2.5 Summary of User Interface Findings

As a whole, RWIS is easy to learn, and generally easy to use. The training and documentation support are of good quality; and the users find this support to be convenient and useful. There are a number of interface improvements that could be made; but none that represent critical requirements.

5.3 Operations Monitoring

In this section we will describe the results of analyses of several sets of statistics that were collected during the second winter trial. The statistics were collected from three sources, the MTC road and weather reporting system, a user logging form, and usage statistics collected by the RWIS vendor. The user logging form was used by patrol personnel to record information about usage each time they signed onto the system. A copy of the form is shown in Appendix D.

The statistical data were collected to answer three questions:

1) How much do users use RWIS?

2) Why do users use RWIS?

3) Is there a linkage between weather conditions and using RWIS?

In the remainder of this section, we will present the results of analyses that were designed to answer these questions.

5.3.1 Usage Statistics

Table 1 shows tabulations of monthly usage statistics for the six District 6 RWIS terminals. It can be seen that the Patrols and the Radio Room had the highest rates of usage; generally four to five times greater than the usage rates for the terminals in the Maintenance Office and the RIO. At the patrols, the system was used an average of about 15 times a day. Two distinct patterns of usage can be seen in the totals for the patrols. Patrols 602 and 611 tended to have longer terminal sessions with fewer numbers of sign-ons, while Patrol 641 tended to have shorter sessions with more sign-ons. We did not find any obvious reason for this difference in usage patterns.

Table 1: Monthly statistics on total hours of RWIS usage, and numbers of RWIS sessions, for District 6 terminals during the second winter trial.

	Radio Room		Maintenance Office		Public Information	
	Hours Usage	No. of Sessions	Hours Usage	No. of Sessions	Hours Usage	No. of Sessions
December	72.2	289	25.4	81	20.1	83
January	89.0	338	14.9	43	4.8	12
February	88.3	390	21.4	112	18.1	61
March	74.2	341	14.5	47	23.4	163
Totals	323.7	1358	76.3	283	66.4	319

	* Patrol 602		Patrol 611		Patrol 641	
	Hours Usage	No. of Sessions	Hours Usage	No. of Sessions	Hours Usage	No. of Sessions
December	0.0	0	137.9	379	74.4	560
January	35.6	44	164.6	475	84.3	558
February	109.7	384	143.1	427	69.4	553
March	64.7	291	99.7	288	62.7	506
Totals	210.0	719	545.3	1569	290.8	2177

* Note that Patrol 602 did not have a terminal installed until the end of January.

The distribution of session lengths for the patrol users is shown in Figure 1. The bar graph in Figure 1 shows an exponential distribution with larger numbers of short sessions, and decreasing numbers of long sessions. Because of the shape of the distribution, the overall mean session length of 14 minutes is somewhat misleading as an indicator of the lengths of typical sessions. In fact, half of the sessions were less than 10 minutes long.

Figure 2 shows a bar graph of the times of day when patrol users signed onto RWIS. It can be seen that usage was fairly evenly spread around the clock. The minor peaks in the distribution correspond to times at which patrols entered their road and weather reports.

The general pattern of patrol usage, as well as indicating that Patrol personnel found the system to be useful, also shows an almost ideal usage pattern for minimizing the cost of the computer and communications support for the system. The short session lengths, spread around the clock, mean that the RWIS computer can maintain a relatively constant utilization rate throughout the day, and that the computer does not have to deal with extreme peaks of usage.

5.3.2 Reasons for RWIS Use

Table 2 shows a listing of the RWIS menu selections ordered according to how often users in the user opinion survey said they used each menu selection. In the survey, which will be described in detail later, users were asked to say for each RWIS menu selection, whether they used the selection often, sometimes, or seldom. Since the survey sample contained only 15 users, we have not shown quantitative data in Table 2.

The position of each menu selection in the list in Table 2 reflects the number of users who reported using the selection "often". A list made up according to numbers of users who said they used a selection either "often" or "sometimes" yields essentially the same ordering as the ordering shown in Table 2. The Table shows that except for the Road Report Program, the

Figure 1: Bar graph showing distribution of lengths of RWIS terminal sessions for the District 6 Patrols from 1 December, 1986 to 31 March, 1987.

Session Length in Minutes	Number of Sessions	Percent	
5 or less	1582	35.4	++++++++++++++++++++++++++++++
5.1 to 10	732	16.4	++++++++++++
10.1 to 15	519	11.6	++++++++
15.1 to 20	712	16.0	++++++++++++
20.1 to 25	276	6.2	++++
25.1 to 30	215	4.8	++++
30.1 to 35	124	2.8	++
35.1 to 40	85	1.9	++
40.1 to 45	62	1.4	++
45.1 to 50	34	.8	+
50.1 to 55	25	.6	+
55.1 to 60	18	.4	+
Over 60	81	1.8	++
Total	4465		

Figure 2: Bar graph showing distribution of times of day of RWIS terminal sessions for the District 6 Patrols from 1 December, 1986 to 31 March, 1987.

Hour of Day	Number of Sessions	Percent	
0:00 to 0:59	125	2.8	++++++
1:00 to 1:59	101	2.3	+++++
2:00 to 2:59	84	1.9	++++
3:00 to 3:59	83	1.9	++++
4:00 to 4:59	220	4.9	++++++++++
5:00 to 5:59	139	3.1	++++++
6:00 to 6:59	196	4.4	+++++++++
7:00 to 7:59	203	4.6	++++++++++
8:00 to 8:59	155	3.5	+++++++
9:00 to 9:59	252	5.6	++++++++++++
10:00 to 10:59	245	5.5	++++++++++++
11:00 to 11:59	195	4.4	+++++++++
12:00 to 12:59	190	4.3	+++++++++
13:00 to 13:59	177	4.0	+++++++++
14:00 to 14:59	315	7.1	++++++++++++++++
15:00 to 15:59	276	6.2	++++++++++++++
16:00 to 16:59	163	3.7	++++++++
17:00 to 17:59	177	4.0	+++++++++
18:00 to 18:59	158	3.5	+++++++
19:00 to 19:59	151	3.4	+++++++
20:00 to 20:59	177	4.0	+++++++++
21:00 to 21:59	223	5.0	++++++++++
22:00 to 22:59	139	3.1	++++++
23:00 to 23:59	321	7.2	++++++++++++++++
Total	4465		

Table 2: List of the RWIS menu selections ordered according to the numbers of users in the final interviews who said they used the selection often.

Radar images
24 hr. forecast
36 hr. forecast
Road report program
Public forecast
General weather
Hourly radar depictions
Road conditions
Road maintenance
Press Release
District Weather
Winter precip.
X-sections
Ontario weather
Station Reports
Weather warnings
Training
Ontario Districts
HELP

general weather information pages are the most often used pages. The detailed weather pages, such as the Station Reports, and District Weather, tended to be used rarely.

The ordering in Table 2 is weighted towards the preferences of the Patrol personnel because there were more Patrol personnel in the sample. However, when we reviewed the preferences of the District Office, and Headquarters users separately, we found that the District Office and Headquarters users also made heavy use of the general weather pages. The main difference between these users and the Patrol users was that District and Headquarters users mentioned the Road Maintenance and Road Conditions pages more than the Patrol users did.

Figure 3 shows menu usage based on data from the logging forms filled out by the Patrol users. On the logging form, users were asked to record what pages they looked at when they signed onto the system. The form had spaces for recording up to four selections. The results in Figure 3 are derived from aggregating selections across the four spaces that were available on the log form for recording selections. On average, users recorded just over two menu selections on each RWIS session.

The data from the log form have to be treated cautiously because users recorded only some of their sessions on the log form. Of the 4465 sessions recorded by the RWIS computer, only 530 were recorded by Patrol users on the log form. If the sessions recorded on the log form represented a random sample of all of the sessions, 530 log form records would be more than adequate for making statistical inferences. However, the log form records are not a random sample. For example, the patrols varied considerably in the proportions of sessions on which they used the log form. One patrol used the form for about 20 percent of its sessions; while another used the form for only about 5 percent of the sessions. As another source of bias, users would more likely have filled in the log form when they were not in a hurry.

The log form had spaces for recording reasons why the user signed on for each session. Figure 4 shows a bar graph of the how often users gave various

Figure 3: Numbers of times use of different RWIS menu selections were reported by Patrol personnel on the user log form.

RWIS Menu Item	No. Times Selected	% Times Selected	
1 General weather	70	6.0	++++
2 Ontario weather	19	1.6	+
3 Radar images	285	24.4	++++++++++++++++++
4 Hourly radar	59	5.1	++++
5 District Weather	20	1.7	+
6 Station Reports	36	3.1	++
7 36 hr. forecast	77	6.6	+++++
8 24 hr. forecast	148	12.7	+++++++++
9 Winter precip.	59	5.1	++++
10 Weather warnings	52	4.5	+++
11 Public forecast	167	14.3	++++++++++
12 Road conditions	38	3.3	++
13 Road maintenance	23	2.0	+
14 Road report	107	9.2	+++++++
15 X-sections	0	0.0	
16 Ontario Districts	0	0.0	
17 HELP	0	0.0	
18 EXIT	0	0.0	
19 Training	8	0.7	+
	1168	100.0	

Figure 4: Bar graph of reasons given by Patrol personnel on the user log form for using RWIS.

Reason	No. of Times Given	Percent	
Short term weather	292	55.09	++++++++++++++++
Enter road report	144	27.17	++++++++
Long term weather	90	16.98	+++++
Monitor storm start	39	7.36	++
Monitor storm progress	36	6.79	++
Monitor storm end	5	.94	+
Request from another patrol	23	4.34	++
Plan short term operations	67	12.64	++++
Plan long term operations	12	2.26	+
Deploy MTC equipment	5	.94	+
Deploy contractor equipment	19	3.58	+
Recall MTC equipment	1	.19	+
Recall contractor equipment	2	.38	+

reasons for signing on each RWIS session. Note that, because the users could record several reasons for each sign-on, each percentage in Figure 4 is relative to the total 530 log form records. Figure 4 shows that RWIS was used predominantly for checking on the short-term weather forecast, and for entering the road report. There were relatively few instances of use for specific operations planning or decision making.

The small numbers of occasions of use for specific decision making purposes was due in part to the small number of occasions when bad weather would require making decisions about such things as deploying or recalling equipment. We attempted to analyze the log form data in conjunction with weather records to see if planning and decision making uses were related to weather conditions. However, there were just too few log form records in which decision making reasons were given to permit this analysis to show any significant patterns.

Although there were not enough data from the log forms to show relationships between specific types of decision making and weather conditions, there were data from other sources that showed a relationship between RWIS usage and weather conditions. These data consisted of, on the one hand, the Patrol road and weather reports, and on the other hand, the usage statistics collected on the RWIS computer. We used these two data sources to see if there was a correlation between occurrences of bad weather and volume of RWIS usage.

To create an index of bad weather, we defined for each Patrol, a variable called precipitation. This precipitation variable was defined as the total number of times on each day that a Patrol reported any type of precipitation in its road and weather reports. Thus, if a Patrol never reported precipitation in any of its reports for the day, the value of the precipitation variable for that day would be zero. If the Patrol reported precipitation in five different reports on that day, the value of the precipitation variable for that day would be five.

As an index of daily RWIS usage, we used the Patrol's total number of

RWIS sessions for the day. If Patrol personnel were using RWIS at least indirectly for operations decision making, we would expect to see higher volumes of RWIS usage on days when there was precipitation.

Table 3 shows a set of correlation coefficients representing for each Patrol, the correlation between the Patrol's reports of precipitation and the Patrol's volume of RWIS usage. Table 3a shows results for the whole winter trial period for Patrols 611 and 641. Since Patrol 602 did not have a terminal until the end of January, data from Patrol 602 are not included in Table 3a. Table 3b shows correlations for all three patrols over the period when all three patrols had terminals.

The correlation values in Table 3 all show significant relationships between the presence of precipitation and the use of RWIS: the greater the numbers of reports of precipitation, the greater the volume of RWIS usage. In addition to the correlations shown in Table 3, we computed a variety of correlational relationships such as the correlation between total reports of precipitation from all Patrols with the total volumes of usage by all three Patrols. All of the correlations showed moderate but consistent relationships between the presence of precipitation in the weather and volume of RWIS usage. Of particular interest were the time lagged correlations between precipitation and RWIS usage. These showed that not only did RWIS usage increase on days of precipitation, but also that usage began to increase from one to two days before the occurrence of precipitation. This is what we would expect to see if Patrol personnel began checking the RWIS information more often as soon as they realized that a weather system was approaching the District.

5.3.3 Summary of Usage Statistics

The statistics describing RWIS usage showed that Patrol personnel were the heaviest users of RWIS. The radar display was by far the most used page by all users, followed by the general weather pages. Patrol usage was significantly related to the presence of precipitation in the weather. This

Table 3: Correlations between reports of precipitation in the Patrol road and weather reports, and volume of use of RWIS. Table 3a shows the correlations for Patrols 611 and 641 for the period 1 December, 1986 to 15 March, 1987. Table 3b shows correlations for all three Patrols for the period 1 February to 15 March, 1987, when all three Patrols had terminals.

3a Period 1 December, 1986 to 15 March, 1987.

	Patrol 611 Usage	Patrol 641 Usage
Precipitation	0.30	0.42

3b Period 1 February to 15 March, 1987

	Patrol 602 Usage	Patrol 611 Usage	Patrol 641 Usage
Precipitation	0.29	0.42	0.52

suggests that RWIS was regarded as being relevant to managing Patrol operations during bad weather. However, there was little evidence that patrol personnel used the system for specific types of operations decision making.

5.4 Final Interviews

The final interviews were conducted at the end of the second winter trial. Fifteen users were interviewed. Three users were interviewed in each Patrol; the Patrol foreman or supervisor, a patrolman, and a clerk (usually called checker). In addition, we interviewed three District level maintenance supervisors, the supervisor of the Radio Room, and the two senior personnel in the RIO. All except one of the persons who were interviewed had direct access to an RWIS terminal, and made regular use of RWIS as part of their jobs.

The protocol for the interview is shown in Appendix D. Although the interview had a standard format, it was conducted in a fairly informal manner. Time was allowed for respondents to discuss each topic at whatever length they liked. And the interview protocol was adapted by the interviewer as necessary to reflect the job characteristics of different users.

The interview covered three main topics. The first topic concerned how the user used RWIS in his or her job. The second topic concerned the convenience of RWIS and personnel issues related to using RWIS. The third topic concerned impacts of RWIS on the effectiveness or efficiency of the users' operations. In the remainder of this section, we will describe the interview results for each of these three topics. In presenting the interview results, we will not describe answers to each item on the interview protocol separately. Instead we will combine responses to groups of items so that we can summarize the interview results by reference to relevant evaluation issues.

5.4.1 Use of RWIS

Almost all of the respondents said that they used RWIS at least once a day. Answers to the question about how often different RWIS pages were used have already been tabulated in Table 2. In general, the radar display, and the related weather forecasting pages were the most frequently used pages. After the weather pages, users had different usage patterns that reflected their different job demands. The patrolmen, checkers, and Radio Room personnel made more frequent use of the road report program. District level and Headquarters users made more frequent use of the road conditions and operations pages. The Public Information users made more frequent use of the press release page.

After being asked how often different pages were used, the users were asked how they used the information from the most frequently used pages. In the case of the weather pages, users reported that they used the information to monitor the weather, largely to anticipate the increased work activity that bad weather brings. Consistent with conclusions drawn from the usage statistics, few users reported interpreting details of weather information to make specific operations decisions.

On the whole, the reasons for using particular non-weather pages were consistent with the users' job responsibilities. However, using RWIS as a general information source rather than as an aid for specific decision making was a constant theme in all of the reasons that users gave for using different information pages.

On questions designed to determine if RWIS provided improved weather information compared with sources that were available to users before they had RWIS, users were generally unanimous in saying that RWIS gave more accurate and more up-to-date information than they had before. A particular advantage of RWIS was that the user could get information when he or she needs it. For a few users, RWIS provided weather information at a greater level of sophistication than was available from conventional sources. Because of the greater sophistication, these users thought they could make

more intelligent operations decisions than they could before they had RWIS.

5.4.2 RWIS Convenience and Personnel Impacts

In responses to a set of questions about the convenience of using RWIS, users gave responses that were generally consistent with the findings described earlier in the section titled Human Factors Assessment of RWIS. Users found RWIS generally easy to use, and easy to learn to use. All of the significant complaints mentioned in the interviews have been addressed in Appendix B which contains suggestions for design improvements.

In the case of impacts on personnel matters, users generally reported either no impacts, or minor positive impacts. The installation of RWIS did not create significant organizational or procedural disruptions of the types that are sometimes associated with implementing automated systems. There were no users whose lack of previous computer experience caused more than some initial anxiety about using the system. No one reported stress impacts due to pressure to learn how to use RWIS, or due to threats to job security, or due to morale problems associated with having RWIS.

Although most users noticed specific concrete changes in work methods due to RWIS, no one found that their overall job changed significantly because of using RWIS. For almost all users, RWIS provided some job enrichment, an opportunity to learn some new technology, and increased self-confidence about being able to deal with technological changes.

In response to questions about how RWIS might affect such things as job classifications, employment opportunities, and the like, most users thought that RWIS would have little impact. No one saw RWIS as significantly changing employment opportunities in MTC. Several management-level personnel thought that they would keep RWIS in mind when filling jobs that would require using RWIS; but in view of how easy it is to learn to use RWIS, ability to operate RWIS would not be a significant factor in screening applicants for such positions. On balance, almost all users thought that the

personnel impacts of RWIS were small, but generally positive.

5.4.3 RWIS Efficiency and Effectiveness Impacts

All users were asked questions designed to get them to think of instances where the use of RWIS had improved operations, or resulted in decreased operating costs. In the Public Information function, RWIS provided significant improvements in the quality of information provided to the public. However, it was difficult to objectively assess the value of the improvement. At the same time, there were no obvious ways in which RWIS produced cost savings in providing information to the public.

General management personnel in the maintenance function thought that RWIS allowed them to better anticipate demands on the winter maintenance systems, but they could not think of many specific incidents where use of RWIS led to cost savings.

At the patrols, some users believed that RWIS could provide several specific operating benefits. These benefits included improving the timeliness with which they scheduled operations during bad weather, and improving their control over the amounts of personnel, equipment, and materials used in operations. However, none of the patrol users could think of more than isolated incidents where use of RWIS had resulted in obvious operations improvements, or identifiable savings on operating costs. For example, at one patrol, use of RWIS was thought to reduce needs for patrolling, especially at night. At the same patrol there were also several instances where RWIS had prevented some unnecessary salting and plowing.

While there were specific instances where RWIS had positive impacts on patrol operations, there were also instances where reliance on RWIS had negative impacts. For example, based on the radar information, one patrol supervisor let contract personnel go home when, as the weather turned out later, he should have kept them on standby. Although patrol users did not think that RWIS would lead to general deterioration in the quality of

decision making, incidents like these were enough to show that using RWIS would not make patrol personnel immune to occasionally making bad operating decisions.

Taking the maintenance users' overall opinions on the impact of RWIS on efficiency and effectiveness, it was clear that the operations decision maker must still rely on exercising judgment in a context of uncertainty and incomplete information. It is very difficult for anyone making this type of decision to articulate what role having a certain source of information might have played in whatever decision was made. And it is even more difficult to independently assess whether or not the decision maker's perception of his or her decision process is accurate. Consequently, the fact that users could not articulate if or how RWIS affected the quality of operations decisions, does not mean that RWIS had no impact on decision making. It only means that the impact of RWIS on operations decision making must be assessed by indirect methods.

In the final part of the interviews with management level personnel, we asked respondents about office work that could be supported with microcomputer applications. The reason for these questions was that a microcomputer could be used as an RWIS terminal instead of the stand-alone decoder terminal that was used in the trial. Having RWIS on microcomputer terminals would provide two potential benefits. The cost of operating RWIS on a microcomputer terminal might be less than operating it on a decoder terminal if the microcomputer could be used for other productive applications in addition to accessing RWIS. Although the decoder terminal is cheaper than a microcomputer, it cannot be used for anything other than accessing RWIS, or at best, other Telidon information services.

Having RWIS on a microcomputer would also permit enhancements to the RWIS service itself. RWIS page displays could be stored on the microcomputer disc storage; either for short term quick reference, or for permanent storage. For example, in the case of a developing storm, it would be useful to be able to replay a series of pages to get a picture of the trend of the storm's development. The disc stored pages would be much better than the

small monochrome printouts produced by the existing terminal printers that are now the only means of recording page displays.

Certain uses of RWIS could also be automated by the microcomputer software. A number of users, if not most users, sign on at regular times, and usually look at the same pages. The microcomputer could be programmed to sign on at preset times, and record specific RWIS pages on disc. The user could then look at these pages at his or her convenience by retrieving them from disc storage. The time it would take the user to retrieve the pages from disc would also be shorter than the time the user would have to wait while the pages are painted on the terminal screen as they are transmitted from the RWIS computer. The microcomputer could also be programmed to automatically transmit a patrol's road and weather reports. Automated RWIS usage would be convenient for small patrols where personnel cannot always be in the office when a road and weather report is to be entered, or when it would be desirable to retrieve certain pages from RWIS.

In responses to questions about microcomputer office applications, almost all of the management and supervisory users thought of applications that could be useful. In general, the applications included record keeping, data entry for management information systems, and local budgeting and planning applications. Some users also had word processing applications. The Radio Room was the only location that did not have significant or obvious applications for an office microcomputer.

Of significance in the responses to questions about microcomputer office applications, was the fact that the RWIS users appeared to perceive implementing RWIS on microcomputers along with other office applications as a natural and welcome step in the evolution of maintenance systems development.

5.4.4 General Attitudes to RWIS

Taken piecemeal, the final interview results, along with results from other components of the evaluation, may be somewhat misleading. On most of the user evaluation issues, the findings suggest that on average, users had generally positive views about RWIS. Indeed, most users were moderately to strongly positive about RWIS. However, from our contacts with users throughout the second winter as well as in final interviews, we found a significant number of users whose attitudes to RWIS were from moderately to strongly negative.

The cause of some negative reactions appears to be related to the nature of maintenance operations management. In maintenance there are essentially two approaches taken to winter operations management. One approach consists of trying to anticipate and plan for operations: when snow is on the way, get everything ready to deal with it. The other approach consists primarily of reacting to demands: when there is snow on the road, go and clean it off. We will not discuss the relative merits of these different approaches because we found no evidence to show that one approach worked better in practice than the other. However, there was a relationship between users' attitudes to RWIS and which approach they took in managing maintenance operations.

Users who managed primarily by reacting to conditions tended to have negative attitudes to RWIS. While these users made as much use of RWIS as other users, they would have been happier without RWIS. They tended to use RWIS to check on the weather rather than to use RWIS as a significant planning tool. They were reluctant to put effort into interpreting RWIS information; and they did not put much reliance on RWIS information. Indeed, some of these users found that RWIS was an imposition; and we believe, an implicit criticism of their management approach.

We will discuss the reasons for some of the negative attitudes in more detail in the Discussion section. For the time being, we note that some users expressed these attitudes; and that these attitudes were not necessarily reflected in other findings such as the usage statistics. These

users found RWIS as easy to use as other users did. Since they did not operate without some degree of reliance on weather information, they liked being able to get weather information on demand. But given their operations management approach, RWIS was of very marginal value relative to the nuisance values of such things as the space taken up by the terminal and time taken up by training personnel, not to mention the modest disruptions caused by our evaluation activities.

5.4.5 Summary of Final Interview Findings

Users' opinions in the final interviews were consistent with findings derived from other components of the evaluation procedure. Views on the RWIS terminal interface were consistent with the findings in the user interface review. Users perceptions of their amounts and patterns of usage were consistent with findings from independent data sources such as the system usage statistics.

In opinions about the personnel impacts of RWIS, users were generally mildly positive. The use of RWIS did not have any negative personnel impacts; and it provided a modest improvement in job interest.

Most users thought that RWIS had, or could have, positive impacts on operations efficiency and effectiveness. However, none of the users could describe significant concrete ways in which RWIS provided operational benefits. To the degree that RWIS serves as a decision support system, it appears to increase information and reduce uncertainty for decision makers who have to rely on judgment and experience for making decisions. The decision support provided by RWIS does not appear to change the nature of operational decision making. Decisions made with incomplete information are still made with incomplete information, albeit information that is less incomplete than before.

6.0 DISCUSSION

We will discuss the results by reference to four main evaluation issues:

1) general RWIS usabiiity;

2) impacts on organization;

3) impacts on operations and RWIS cost-effectiveness;

4) attitudes about RWIS.

6.1 RWIS Useability

The trial showed that in its mechanics, RWIS is easy to learn, and easy to use. There are some ways in which the user interface can be improved, but most of the improvements would be minor.

The quality of training for using RWIS was more than adequate relative to the objectives set for the training program. However, the findings from the user evaluation suggest that greater depth is needed for some of the weather topics. Users found that the radar was sometimes unreliable. We believe that in many cases, the apparent unreliability of the radar resulted from lack of knowledge of the details of how weather radar works, and lack of knowledge about weather situations that make it necessary to treat radar information cautiously. Many, if not most users treated the radar as if it provided a literal display of precipitation patterns on the ground, when in fact, the precipitation pattern on the ground could be substantially different from the one shown on the radar display.

There were also difficulties in interpreting weather information from the weather maps. The training provided a good introduction to interpreting weather maps, but we found that there was considerable variability among users in their abilities to interpret weather map information in terms of

operating decisions. Out of natural interest, some users became quite sophisticated in using the weather maps. Other users used weather map information only to get gross overviews of developing weather patterns. In our opinion, it will be necessary to train users to a greater depth of weather sophistication than the present training package provides before RWIS can be fully exploited.

The pattern of RWIS usage shows that users used RWIS primarily as a weather information system; with other uses reflecting specific job functions such as entering patrol road and weather reports. Within the weather information context, the radar, the weather maps, and the general forecast were by far the most frequently used system pages. Some weather pages such as the District Weather and Station Reports were used very little. If the cost of maintaining individual pages is significant, some pages could probably be eliminated.

6.2 Impacts on Organization

The findings from the final interviews, and from observations throughout the trial, show that RWIS had generally small put positive impacts on organizational matters. Most users received some job enrichment benefits from their experience with RWIS. For most users, the installation of RWIS did not threaten job security, or devalue existing skills or responsibilities. Some users perceived improvements in their effectiveness as a result of having access to RWIS. The use of RWIS caused noticeable changes in some work procedures, but users easily adapted to these changes.

A significant number of maintenance users had a general negative view of RWIS. These views did not reflect differences of opinion from other users about such issues as ease of use, or organizational impacts. Instead, for these users, RWIS had little utility in improving operations decision making compared with the inconveniences created by having the terminal installed, and the inconveniences created by the evaluation trial. It appeared that the view of these users reflected an approach to operations management that

relies little on predicting weather; and instead relies heavily on patrollers' reports, and on being able to react quickly to winter operations demands. These users did not perceive enough utility in RWIS to cause them to change their approach.

For users who did not see much utility in RWIS, there was an additional element of negative reaction that may have reflected more than just the reaction to a system that has little utility. The implementation of RWIS may have been perceived as a threat to an established and traditional operating procedure. Although this was not intended, there was little done in the implementation process to forestall this reaction. There was little consultation with potential users in selecting users for the trial. Users were not prepared for the installations. In most cases, terminals were installed, and the users were left to their own devices in making use of the RWIS services. None of the users were thoroughly briefed on the strategic issues that the Ministry was aiming to address in the trial. Virtually all of the users had to struggle to identify just what was expected of them in the trial. It is thus not surprising that some users misinterpreted the implications of the RWIS installations.

6.3 RWIS Cost-Effectiveness

Since there was a separate study being conducted to establish the cost-effectiveness of RWIS, a cost-effectiveness investigation was not included in the user evaluation. However, we did attempt to find out if patrol users had identified specific ways in which RWIS would improve the cost-effectiveness of their operations.

Although the findings as a whole showed that the majority of users found benefits from using RWIS, none could cite more than isolated concrete instances where the use of RWIS reduced costs, or produced measurable increases in productivity. For maintenance users, RWIS helped the user to be better informed about the weather, and by inference, helped the user to make more cost-effective operations decisions. But the depth or nature of RWIS

information was not at the level that tells the user, for example, to plan to start plowing at a specific time. The maintenance operations decisions remained being decisions made with incomplete information. Although RWIS may have permitted decisions to be made with more complete information than before, the fundamental need to apply experience and good judgment to decisions did not change. Consequently, it was difficult for maintenance users to objectively assess how much operations decision making would be improved by having access to RWIS.

In some situations, the use of a new system produces specific changes in operations that can be easily identified; such as eliminating certain costly steps in a production process. In such situations it is easy for system users to identify cost-effectiveness impacts; and in turn, it is easy to devise measures to see if the users' perceptions of particular system impacts are correct. In the case of RWIS, users could not identify simple cost-effectiveness impacts that could be easily measured independently of other factors that affect operational cost-effectiveness. This means that the operational impacts of RWIS would have to be measured by seeing if RWIS permitted users to be more cost-effective in their overall operations, rather than by seeing if RWIS made specific components of operations more cost-effective.

From information gathered in the user evaluation, the question of RWIS cost-effectiveness for patrol installations remains moot. In addition, the user evaluation findings suggest that a field experiment to assess RWIS cost-effectiveness would have to have a high degree of measurement precision. From the types of impacts perceived by users in this trial, even if the cost-effectiveness benefits of RWIS are significant, they are likely small relative to total patrol maintenance expenditures. More important for measuring impacts, the impacts of RWIS are likely to be small compared with the general year-to-year variability in patrol expenditures. Although only small amounts of benefits would be required to cost justify RWIS, detecting the benefits in a field experiment could require having to compare a large number of RWIS test patrols with a similarly large number of non-RWIS patrols. If a large scale field experiment were required, the cost of the

field experiment itself could cancel the potential benefits of installing the system being tested.

Another approach to RWIS cost-effectiveness would be to treat RWIS as only one of several applications that might be considered for computer installations in patrols. In fact, patrols appear to have computer applications that are at least as obvious if not more obvious than the application for RWIS. As described earlier, the cost of RWIS would be substantially reduced if the terminal cost was shared by other applications. Operating RWIS on a microcomputer would also provide advantages in the use of RWIS that are not possible with the present passive terminal. However, although there are a number of obvious applications for patrol computers, a proper needs analysis would be required to establish the benefits of these applications.

6.4 Conclusions

The findings from the user evaluation show that RWIS is well designed, easy to use, and easy to learn to use. The organizational and personnel impacts of RWIS are minor, and generally positive. During winter operations there were generally high levels of usage, particularly by patrols. The patterns and volumes of usage show that users perceive the system predominantly as a general weather information system. The relationship between volume of usage and the occurrence of bad weather conditions shows that users treat RWIS as an important information source for managing maintenance operations. For general design and user acceptance, RWIS is an acceptable system.

However, a major factor in operations decision making is reliance on experience and judgment in a context of incomplete information. While RWIS information reduces uncertainty about weather, it does not change the nature of the operations management decision processes. A related factor in the use of RWIS is that the ability to exploit RWIS information depends heavily on the user's weather sophistication. These two factors have several

implications.

The nature of RWIS information, and the nature of the operations decision-making process, make it difficult to objectively and quantitatively assess the benefits of RWIS. The use of RWIS also requires a good deal of training support to ensure that the users maintain weather information interpretation skills that are needed to properly exploit RWIS information.

Finally, the nature of patrol operations permits some proportion of potential RWIS users to operate by relying on reacting quickly to whatever weather comes along. These potential users may have to be convinced not only that RWIS offers operational decision-making benefits, but also that the benefits are enough to make it worth changing their operations management approach from a reactive style to a proactive style. Any pressure, implicit or explicit, on potential users to change their management approaches is bound to create anxieties, and in some cases negative reactions. Any implementation of RWIS would have to be carefully handled to ensure that such sensitivities are taken into account. The ease with which users can start operating RWIS makes the task of implementing it easier, but it does not diminish the need to follow established practices for introducing users to new systems.

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APPENDIX A

RWIS System Description

The first section of this appendix describes the general operation of RWIS. The second section describes the functions of the individual system display pages.

A.1 System Description

RWIS is a videotex information system that distributes road and weather information. The system is designed primarily for use in two MTC functions; road maintenance operations and public information services. In road maintenance operations, RWIS provides weather information that maintenance personnel can use for deciding on deploying equipment, materials, and personnel. In public information services, RWIS provides information about road and weather conditions that public information personnel can pass on to members of the public, either directly, or through distribution to local media.

RWIS is maintained on a central computer. Users gain access to the system from remote terminals through conventional telephone connections. The RWIS terminal consists of six components:

1) a high resolution colour television monitor;

2) a modem for communications with the central computer;

3) a conventional computer keyboard for issuing RWIS system commands;

4) a thermal printer that produces a 11.6 cm. by 8.7 cm. black and white copy of the monitor display;

5) a remote hand-held commander that can be used to issue commands instead of using the computer keyboard; and

6) a Videotex decoder that decodes the videotex signal for display on the television monitor; and links together the monitor, modem, keyboard, printer, and remote commander.

When the RWIS terminal is turned on and connected to the central computer, the system displays a menu of 20 functions. Six of the functions provide information about current weather conditions. Five of the functions provide weather forecast information. Four more functions provide information about road conditions. In addition to the information functions, there is a function that can be used by authorized personnel for entering information into the RWIS data base. There is also a Help function, and a Training function.

The user can make a menu selection by typing the number of the selection on the computer keyboard, or by punching a selection number on the remote commander. When a selection is made, the system produces either a graphic or a text display that contains the information described in the menu label.

In addition to being able to view individual system pages, the user can obtain a dual display showing two system pages side by side; for example, a display showing the Exeter weather radar display on the left, and the King City weather radar display on the right. To produce the dual displays, the system has to foreshorten the horizontal axis of each page so that both will fit on the screen side by side.

The information displayed by RWIS comes from two sources. The weather information is supplied to the central computer from the Atmospheric Environment Service (AES) of Environment Canada. The road information comes from District road maintenance personnel. One of the RWIS main menu functions can be used by authorized District personnel to enter road reports directly into the system. If RWIS were fully implemented, a user could obtain weather and road information for any MTC District in the province.

A.2 RWIS Page Descriptions

The following gives a description of the contents of each of the RWIS pages.

1 **General weather** This shows a current weather map covering eastern central North America.

2 **Ontario weather** This shows a weather map covering Ontario and south-western Quebec, at about twice the scale of the eastern central North America map.

3 **Radar images** This menu selection provides access to current weather radar depictions from radar sites in Ontario. Each display shows the location and intensity of precipitation for a radius of about 200 kilometers around a radar site. The displays provide complete coverage of Ontario, south of a line from about Thunder Bay to Pembroke.

4 **Hourly radar depictions** This shows precipitation patterns averaged over the past hour for the radar sites shown in menu selection 3. The displays do not show literal averages of precipitation, but instead, show schematic depictions drawn by AES meteorologists to show general areas of precipitation, and the direction of movement of the areas of precipitation.

5 **District Weather** This display shows a map of the highways in the District. Small clusters of weather information symbols are shown at

locations of airport weather stations. Each cluster shows the temperature, cloud, precipitation conditions, wind direction, and wind speed.

6 **Station Reports** When this function is selected, the system displays a menu of items corresponding to the five weather stations shown on the District Weather display, plus a menu item for "other stations". If the user selects a local station, the system produces a text display showing weather data for the selected station. The "other stations" selection produces another menu that lists all of the weather stations in Ontario.

7 **36 hr. forecast** This display is the same as the weather map display for the General Weather (menu item 1) except that the map covers almost all of Canada and the United States instead of just the eastern half of central North America. The display shows what the weather map is predicted to look like at the date and time shown in the upper right corner of the display, which would be about 36 hours from the time that the display is being viewed. The display is updated every 12 hours.

8 **24 hr. forecast** This is the same as the 36 hour display except that it covers a smaller area (the same area as the general weather display covers), and it predicts the weather 24 hours in advance.

9 **Winter precip.** This selection produces a menu that lists selected airport weather stations. When a station is selected, a display appears showing two columns of data, with the data labels on the left. The left data column shows the precipitation forecast for the next 12 hours, and the right hand column shows the forecast for the succeeding 12 hours. The data given in each column include the amount of precipitation; type of precipitation; snow amount; the start, change, and end of precipitation; and wind and temperature information.

10 **Significant weather warnings** This selection produces a menu in the form of a map showing regions north and south of the Great Lakes. Selecting one of the regions produces a text screen which would describe the nature and location of any severe weather in the region. When the user signs onto RWIS, the menu selection number (10) is shown in a different colour from the other selection numbers if there are any weather warnings in effect.

11 **Public forecast** This selection produces a menu consisting of a list of AES's Ontario forecast regions, and a map showing the location of each region. When a region is selected, a text screen appears showing the public forecast for the region.

12 **Road conditions** This selection produces a map of the District in which the user's RWIS terminal is located. The map shows the highways in the District, and the locations of patrol yards. The highways can be shown in different colours to indicate the road conditions. A flashing dot can also be displayed on a highway to indicate that a road is closed. The road

conditions function can be used to access road conditions information for Districts other than the user's own District.

13 **Road maintenance** This selection produces the same map display as the road conditions display, except that the colours of the roads represent the type of maintenance operation currently underway. The user can also get access to maintenance operations displays for other Districts.

14 **Road report program** This is a data entry function that patrols can use to report local weather conditions, road conditions, and current operations. The information reported is the same information that patrols report in their regular five-times-a-day radio reports.

The sub-menu on the road report program also permits the user to view the contents of current reports entered for all of the patrols in the District. The information is shown in a tabular format so that, for most Districts, all of the patrol reports can be seen at once.

15 **X-sections** This selection displays longitudinal cross-sections of major highways: Highway 401 from Windsor to Toronto, Highway 401 from Toronto to Montreal, Highway 400, and Highway 417-17 from Pembroke to the Quebec border. On the display for each highway, the road is represented by a horizontal bar across the screen. A scale below the bar shows distance graduations, and the locations of major cities along the route. Colour coding of the bar indicates the condition of the road at different points along the route. Above the bar representing the road, there is an area that symbolically displays weather conditions at different points along the highway.

16 **Ontario Districts** This selection produces a map showing MTC District boundaries. The Districts are numbered so that typing a District's number would give the user access to the data base for the selected District. Normally, when a user signs on, RWIS automatically produces District specific displays that correspond to whatever District the user's terminal is located in. The Ontario Districts selection lets a user in one District see the displays that RWIS would produce automatically for a user in another District.

17 **HELP** This function contains generally the same information a.. the RWIS User's Guide. It gives a description of each of the information functions, as well as listings of command keywords, and letter identifier codes for weather reporting stations, public forecast regions, and so on. When the user selects HELP, a menu is presented listing the different topics that the user might want assistance with.

18 **EXIT** This selection disconnects the terminal from the central computer, and displays a thank-you message with a telephone number to call for more information.

19 **Training** This gives the user access to a set of pre-programmed RWIS displays that are meant to be viewed while the user studies the RWIS Self-Instruction Workbook.

20 **Press Release** This displays a public information services press release summarizing the road conditions across the province.

APPENDIX B

Suggested RWIS Design Improvements

This appendix contains suggestions for RWIS design improvements. The suggestions were derived from the interface review, and from observations made by users. The first part of the appendix describes general improvements that apply to the operation of the system as a whole. The second part of the appendix addresses improvements that apply to individual display pages.

B.1 General Improvements

Time Formats Most RWIS pages display date and time-of-day information. In the interface review for the first winter trial, we observed a wide variety of formats for displaying date and time information. During the most recent review, we observed that significant improvements had been made in standardizing the date and time formats. Nevertheless, there are still several different date and time formats used on different pages. In addition, for some pages, it is difficult to know what the date and time refer to. For example, on the morning of 17 February, both the 24 hour and 36 hour forecast pages showed the same date and time, 18 February, 0700. Actually, the pages show the date and time in the upper right corner of the page as:

FEB
180700L

which is not itself an easy format to interpret.

For weather information pages during storm situations, there are several times that are important to the user; when the information was last updated, the period for which the information is valid, and when the information will be updated again. It would be worth considering dedicating a line of the display to providing date and time information in a standard format. This could be done on most pages by using the first line of the display for the page title and date, and the second line for time information. This would mean removing, or reducing the size of the RWIS logo which now takes up most of the top line of each page.

Keyword Commands We did not find any users who consistently use keyword commands to get access to pages and functions. The keywords are numerous, and not easy to remember. Users were generally satisfied with using the menus to get access to different functions. The keyword commands could be eliminated, or reduced to a few representing the main menu selections. A few main menu keywords would be a convenience for users who habitually look at the same sequence pages whenever they sign on.

Prompts RWIS is generally rather stingy in providing prompts. An

exception is the Districts menu which shows the prompt "Select DISTRICT # press return". Most pages do not give easy to understand prompts. For example, displays with multiple pages, or multiple legends, only show an arrow and either the letter F or B to indicate how to get to the next page or legend. For most pages, the bottom line of the display could be dedicated to prompts. For example:

More legend = F RETURN Menu = RETURN

Most users access only a few pages regularly; and other users use the system only occasionally. Therefore it is not safe to assume that all of the users will learn and remember all of the system commands through continual use of the system.

B.2 Page Design Improvements

This section refers only to pages in which improvements could be made. Pages that are not referred to in this section were judged to be satisfactory in their present forms. Of the suggested design improvements, those for the Road Report program should be given the highest priority. The improvements in other pages would be useful, but not necessary.

3 **Radar images** Some users have difficulty locating echoes shown on the radar display relative to locations on the ground. It would be helpful to show some highways on the radar display template to provide reference points.

6 **Station reports** The part of the display heading that shows the location of the station should show the name of the station rather than the station's letter identifier code.

10 **Weather warnings** During the trial, the main menu listing sometimes seemed to indicate that there were weather warnings in effect when in fact there were none in effect.

12 **Road conditions** District 6 patrol users thought that the map display should permit displaying the existence of different conditions on different roads within a patrol, instead of having to show the same conditions for all roads in the patrol. Since the patrol personnel know the conditions on their own roads, there is no material impact on patrol personnel by, in effect, averaging all of the patrol's road conditions for the map display. Nevertheless, patrol personnel are concerned that other users would often be misled if they relied on this display for a detailed picture of a patrol's road conditions. District Office personnel are not concerned about the lack of detail on the map since they generally know details of the conditions at different patrols. If conditions can vary

significantly from road to road within a patrol; and these variations do not appear on the display; and furthermore, no one is materially affected by the lack of detail on the display; then we have to wonder if the road conditions display is needed at all.

The problem of lack of detail also applies to the display of freeways. The map should show a double set of lanes for the freeways. For example, the map now shows a freeway closure as affecting both directions of traffic flow, even though it is rare for a freeway closure to affect both directions. It would likely be difficult to show the freeways in enough resolution to show double sets of lanes legibly. To show such detail might require a new page showing just the freeways in a larger scale.

The number of colour codes representing different road conditions is more than the average eye can easily discriminate without continually checking the legend to interpret the meaning of the colour shown on a road. In addition, having such detailed coding for road conditions seems inconsistent with providing only gross information about roads within patrols. Since there seem to be uncertainties about purpose of the road conditions display, it would be worth reviewing its design to see if it serves a useful function.

Road maintenance The road maintenance display is the same as the road conditions display except that road maintenance operations are shown instead of road conditions. Consequently, the observations made for the road conditions page also apply to this page.

Road Report Program The road report input program displays a form with fields to be filled in by the operator. Several fields can accept only pre-defined fixed abbreviations. The following program modifications would alieviate several difficulties that users have with the road report program:

- The prompt area of the page should list the valid entries for any field that is restricted to pre-defined valid entries. Operators should not have to type extra help commands to check on what are allowable entries.

- An entry in a field should be validated by the system as soon as the entry is made. Having to wait until the form has been completed to find out if there are any incorrect entries is usually the single greatest source of annoyance for operators filling in electronic forms. The District 6 patrol personnel were no exception to this general rule. The Road Report software should be modified so that each field entry is validated as the entry is made. The validation would have to be quick enough that the operator does not have to wait for each field to be validated. If the validation cannot be done without imposing delays on the operator, then the validation procedure should be left as it is.

- When all of the fields have been filled with valid entries, the system

should issue a menu-style prompt asking if the operator wants to send the report, edit the report, or cancel the report. When the operator elects to send the report, the system should reply with a clear message either confirming that the report was successfully sent, or telling the operator about problems encountered in submitting the report to the data base.

- The fields in a new report should contain default entries that are the entries made in the patrol's previous report. Most reports contain almost the same information as the previous report, so the defaults would save the operator from having to retype the same information. The old (default) entries should be shown in a different colour from fresh entries, and the operator should be forced to go through the form and accept each entry before the form can be sent.

- The display title should indicate whether a new report is being filled in, or an old report is being modified or corrected.

- The road conditions field should permit several road condition codes to be entered, or there should be an extra comment field to permit patrols to indicate different conditions prevailing on different roads in the district. The concern about being able to enter different conditions for different roads is the same as the concern that we described earlier in connection with the road-conditions and road-maintenance displays.

Entering the road report represents a significant task for patrol personnel. In addition, patrol staffs have to be flexible enough so that different individuals can do the report as needed. Therefore, it is important to make the program convenient for both regular and occasional operators.

APPENDIX C

Observations on RWIS Training

This appendix contains suggestions for improving the training program that was developed to train patrol personnel in the use of RWIS.

C.1 Introductory Session

The half day instruction session was useful for introducing trainees to the training package. Experience with the pilot training suggested that the trainers need to be fairly expert in being able to use the system, and that they should also have their training presentation well rehearsed.

C.2 Workbook

Introduction It would be useful to show the communications relationships among the RWIS computer, Atmospheric Environment Service (AES) information, and the users' terminals. This would give the trainee a mental model of the system as a whole, and remove some of the mystery that new users perceive about what lies beyond the terminal.

We support the opinions of the users who suggested that the workbook should have illustrations of the system pages referred to in the workbook. Seeing that the page showing on the terminal screen is the same as shown in the workbook gives the trainee an easy way of checking that the display corresponds to what is being read in the workbook. At the beginning of the workbook, the illustrations would build the trainee's confidence that what the workbook says actually happens on the RWIS display. Page illustrations could be used fairly liberally at the beginning of the workbook, and then less frequently once the trainee gets into the body of the workbook.

Weather The content of this section is generally excellent. It is clear that the trainee who is well motivated can develop quite a good level of weather sophistication from mastering this section of the course. Our suggestions on this section are intended to provide modest improvements for an already excellent product.

The workbook contains one significant inaccuracy about wind directions from weather maps. Air moves from high pressure centres to low pressure centres as the workbook says, but gravitational forces cause winds to blow in directions nearly parallel to isobars; clockwise around low pressure centres, and counter-clockwise around high pressure centres. Rough terrain, and other conditions, will cause winds to deviate from blowing strictly parallel to the isobars, but generally one will not be far wrong by using the isobars as a guide to wind direction.

The precipitation effects of troughs and trowals could be simplified, without losing practical instructional impact, by concentrating on troughs, and just mentioning the trowal as a special case. It might also be useful to have a three dimensional drawing of a trough, showing the precipitation effects associated with the trough.

In the general weather section it would be useful to include material on micro-climates to help patrol personnel understand how geography and other environmental conditions affect local weather. Lack of knowledge of micro-climate effects is a significant problem in interpreting general weather forecasts at some patrols.

Radar This section clearly explains the weather radar as far as the currently available information about AES's radar goes. However, many patrol personnel complain that the radar is often unreliable. We believe that this is due, at least in part, to lack of information about the technical characteristics of radar behaviour. We believe that if the patrol personnel could be given more detailed technical information about radar, they would be better able to reliably interpret what the radar displays show. This information could be included in the training package, or it could be provided in special training sessions.

Road Report Trainees mentioned a number of problems connected with entering their road reports. In our opinion, these problems are caused by the design of the report entry program, and not by any weakness in the training materials (see Appendix B).

C.3 General Observations

The workbook is well written, and the demands on reading comprehension level are consistent with the abilities of the trainees. The use of a patronizing style here and there may be somewhat irritating: "Let's take a moment to say a few more words about pressure", for example. Most of these irritations could be removed by changing uses of first person plural to second person, or just declarations: "Here is some more about pressure", for example.

We suggest that if it is feasible, the question and answer material in the workbook should be computerized. This would reduce the trainee's workload, and result in more of them actually doing the questions. It appears now that many, if not most trainees simply read the workbook without doing the questions.

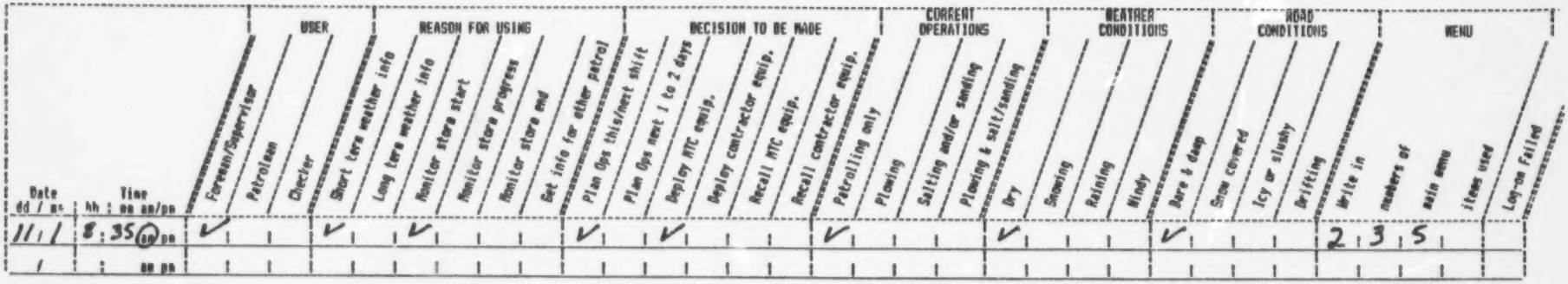
It would make the workbook easier to follow if sections explaining individual system pages had headings instead of being separated or outlined

by heavy lines. The line separators tend to result in visual confusion instead of visual organization.

Overall, the training package is well done, and trainees can acquire levels of weather knowledge consistent with the objectives of the training program.

APPENDIX D

ROAD WEATHER INFORMATION SYSTEM USER INSTRUCTIONS



Date dd / mo	Time hh : mn am/pm	USER: Foreman/Supervisor	USER: Patrolman	USER: Checker	REASON FOR USING: Short term weather info	REASON FOR USING: Long term weather info	REASON FOR USING: Monitor storm start	REASON FOR USING: Monitor storm progress	REASON FOR USING: Monitor storm end	REASON FOR USING: Get info for other patrol	DECISION TO BE MADE: Plan Ops this/next shift	DECISION TO BE MADE: Plan Ops next 1 to 2 days	DECISION TO BE MADE: Deploy NTC equip.	DECISION TO BE MADE: Deploy contractor equip.	DECISION TO BE MADE: Recall NTC equip.	DECISION TO BE MADE: Recall contractor equip.	CURRENT OPERATIONS: Patrolling only	CURRENT OPERATIONS: Plowing	CURRENT OPERATIONS: Salting and/or sanding	CURRENT OPERATIONS: Plowing & salt/sanding	WEATHER CONDITIONS: Dry	WEATHER CONDITIONS: Snowing	WEATHER CONDITIONS: Raining	WEATHER CONDITIONS: Windy	ROAD CONDITIONS: Bare & damp	ROAD CONDITIONS: Snow covered	ROAD CONDITIONS: Icy or slushy	ROAD CONDITIONS: Drifting	MENU: Write in numbers of main menu items used	MENU: Log-on Failed
11 / 1	8 : 35 (am)/pm	✓			✓		✓				✓		✓				✓				✓				✓				2 3 5	
/	: am pm																													

DATE: Fill in the day and the number of the month; for example, January 15 would be entered as '15 / 1'.

TIME: Enter the 12 hour clock time of log-on, and circle 'am' or 'pm' to indicate before or after noon.

USER: Check one box for who used the terminal. Use the box for Checker if the user was someone other than Foreman/Supervisor, Patrolman, or Checker.

REASON FOR USING: Check more than one box if there was more than one reason for signing on. Check the 'Get info for other patrol' box if another patrol requested the information. If another patrol requested the information, leave the rest of the boxes on the line blank.

DECISION TO BE MADE: Check one or more of the boxes corresponding to the operations decisions that RWIS information is to be used for; for example, whether or not to order out NTC plows or sanders.

CURRENT OPERATIONS: Check the boxes that correspond to current winter maintenance operations.

WEATHER CONDITIONS: Check the boxes that represent the weather conditions covering most of the patrol area.

ROAD CONDITIONS: Check the box or boxes that describe the current road conditions for most of the patrol area.

MENU: Write in the numbers of the items on the main menu that were used to get the information you wanted when you signed on.

LOG-ON FAILED: Check this box if you could not access the RWIS computer for any reason.

COMMENTS: If you want to write a comment referring to something in the line being filled in, write the comment in the next line of the log form. If the comment will take up more than one line, use the back of the form or a separate sheet.

ROAD WEATHER INFORMATION SYSTEM USER LOG

Patrol number: _____

Date dd / mm	Time hh : mm am/pm	USER: Foreman/Supervisor	USER: Patrolman	USER: Checker	REASON FOR USING: Short term weather info	REASON FOR USING: Long term weather info	REASON FOR USING: Monitor storm start	REASON FOR USING: Monitor storm progress	REASON FOR USING: Monitor storm end	REASON FOR USING: Get info for other patrol	DECISION TO BE MADE: Plan Ops this/next shift	DECISION TO BE MADE: Plan Ops next 1 to 2 days	DECISION TO BE MADE: Deploy MTC equip.	DECISION TO BE MADE: Deploy contractor equip.	DECISION TO BE MADE: Recall MTC equip.	DECISION TO BE MADE: Recall contractor equip.	CURRENT OPERATIONS: Patrolling only	CURRENT OPERATIONS: Plowing	CURRENT OPERATIONS: Salting and/or sanding	CURRENT OPERATIONS: Plowing & salt/sanding	WEATHER CONDITIONS: Dry	WEATHER CONDITIONS: Snowing	WEATHER CONDITIONS: Raining	WEATHER CONDITIONS: Windy	ROAD CONDITIONS: Bare & dry	ROAD CONDITIONS: Snow covered	ROAD CONDITIONS: Icy or slushy	ROAD CONDITIONS: Drifting	MEMO: Write in	MEMO: numbers of	MEMO: auto wave	MEMO: items used	MEMO: Log-on Failed
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Road Weather Information System 2nd Winter Trial
Final Interview

Name _____ Position _____

Location ____ Date _____

USE OF RWIS

1 How often do you now use RWIS?

Check One

One or more times a day..... _
Two to five times a week..... _
About once a week..... _
Less often than once a week..... _

2 For the following RWIS pages indicate how often you use each page by saying whether you use the page often, sometimes, or seldom. (read list)

	Often	Sometimes	Seldom	DK/R
1 General weather	_	_	_	_
2 Ontario Weather	_	_	_	_
3 Radar images	_	_	_	_
4 Hourly radar	_	_	_	_
5 District weather	_	_	_	_
6 Station reports	_	_	_	_
7 36 hour forecast	_	_	_	_
8 24 hour forecast	_	_	_	_
9 Winter precip.	_	_	_	_
10 Weather warnings	_	_	_	_
11 Public forecast	_	_	_	_
12 Road conditions	_	_	_	_
13 Road maintenance	_	_	_	_
14 Road report prog.	_	_	_	_
15 X sections	_	_	_	_
16 Ontario districts	_	_	_	_
17 HELP	_	_	_	_
19 Training	_	_	_	_

3 For each of the pages you use often, how do you use the information from the page in performing your job?
(Write in page # and reason for use)

Page No. Reason for Use

_ :
_ :
_ :
_ :
_ :
_ :
_ :
_ :

4 Is most of your use of RWIS for: (read list)

a) getting information for your own use __

b) getting information for someone else to use __

c) or inputting information (road report) __

5 Before RWIS, how would you normally get the weather information you needed for your job? (prompt if necessary)

a) Regular MTC weather reports __
b) Broadcast television station __
c) Cable television station __
d) AM or FM Radio __
e) Newspaper __
f) By calling the radio room __
g) By calling (other) patrols __
h) Other (Write in):

6 Do you use these sources of weather information now as much as you did before you had RWIS.

Yes __ No __ DK/R __

7 Are there any features of RWIS weather information that are better than the sources of weather information you had before.

a) RWIS is there when you need access to information __
b) Better information about local conditions __
c) RWIS information is more up-to-the minute __
d) RWIS provides information that is more relevant to my particular needs __

8 (Non-patrol personnel only)
Can you name ways in which access to RWIS weather information saves on your costs, or improves your efficiency, or improves the service your unit provides?

9 Without access to RWIS, how would you normally get information about road conditions and maintenance operations?

10 What do you think are the advantages and disadvantages RWIS compared to the normal information sources for road information.

Advantages Disadvantages

11 How would you make use of RWIS in summer operations?

4. (Non-patrol personnel only)
Can you name ways in which access to RMIS road information saves on your costs, or improves your efficiency, or improves the service your unit provides?

Human Factors Questions

13 Check any of the following problems that you may have experienced in arranging RMIS equipment in your work space:

a) No space for terminal __

b) Finding position without glare on screen __

c) Finding a position for comfortable typing __

d) Finding location convenient to all users __

e) Finding location with room for paper work __

f) Finding location with convenient wiring or phone connections __

14 Did you have any experience with computers before using RMIS.

Yes __ No __ DK/R __ (If no, ask)

15 Compared to learning to use any other equipment you have ever had to learn to use, how difficult would you say it was to learn to use RMIS?

Easy __
About average difficulty __
Quite difficult __

16 Check which, if any, of the following problems are experienced in viewing the RMIS displays.

a) Difficulty in reading text on the screen __

b) Difficulty in viewing graphic displays such as weather maps. __

c) Difficulty in understanding symbols used graphic displays __

17 Do you find that you use the terminal often enough that you can remember all of the commands that you need to use without looking them up in one of the manuals.

Yes __ No __ DK/R __

18 Do you often use the keyboard commands for getting access to RMIS pages, instead of using the menu commands.

Yes __ No __ DK/R __

19 For the following RWIS pages, describe any problems you have using the page, or any improvements you would like to see in the design.

	No Problem	Problem/Improvement
1 General weather	__	
2 Ontario Weather	__	
3 Radar images	__	
4 Hourly radar	__	
5 District weather	__	
6 Station reports	__	
7 36 hour forecast	__	
8 24 hour forecast	__	
9 Winter precip.	__	
10 Weather warnings	__	
11 Public forecast	__	
12 Road conditions	__	
13 Road maintenance	__	
14 Road report prog.	__	
15 I sections	__	
16 Ontario districts	__	
17 HELP	__	
19 Training	__	

Personnel Impacts

20 Has RWIS had any effect on your interest in, or enjoyment of the work you do.

Yes __ No __

Development

Sophistication

Self confidence

Perspective

Work methods

21 Has the RWIS Trial been a source of any stress or unpleasantness for you?

Yes __ No __

(If yes)

Pressure to learn RWIS

Pressure to use RWIS

Pressure on handicaps

Lost skill superiorities

Lost personal productivity

22 Has RWIS produced any morale problems for you or your co-workers?

Yes __ No __

If yes, how were they dealt with?

23 Has RWIS had any impact on your sense of job security?

Yes __ No __

If yes, what impact?

24 Have there been any specific changes in your unit's work methods due to RWIS?

Yes __ No __

If yes, what impact?

25 Have there been specific changes in your own work methods due to RWIS?

Yes __ No __

If yes, what impact?

26 Do you think using RWIS could have an impact on your job classification?

Yes __ No __

If yes, what impact?

27 Do you consider your training for RWIS adequate?

Yes __ No __

For using RWIS functions

For interpreting RWIS weather information

28 Do you think RWIS could affect the type of training or experience that a person coming into your job should have?

Yes __ No __

If yes, what impact?

Training

Experience

29 Do you think that RWIS makes your job more attractive to someone coming into your job?

More __ Less __ No difference __

If 'more' or 'less', why?

30 Has RWIS had any impact on general employee relations in your unit?

Yes __ No __

If yes, what impact?

On general issues

- Pay
- Job security
- Technological change
- Other

31 Has RWIS had any impact on your unit's organizational structure?

Yes __ No __

If yes, what impact?

32 Are there any aspects of your unit's organization that prevent RWIS from being used effectively?

33 Do you think RWIS could change employment opportunities within MTC.

Yes __ No __

If yes, what impact?

PATROLS ONLY

34 Suppose that your patrol had no RWIS terminal, and only the Radio Room and District Office had RWIS terminals. Knowing now what information is available on RWIS, do you think you could get the information you need by calling the Radio Room or District Office instead of getting the information from your own terminal?

Yes __ No __

Why?

35 Can you think of instances where having RWIS has allowed you to:

a) Reduce time spent patrolling __

b) Avoid unnecessary plowing __

c) Avoid unnecessary salting or sanding __

d) Avoid failing to start plowing soon enough __

e) Avoid failing to start salting soon enough __

f) Avoid calling in office staff unnecessarily __

g) Avoid planning general maintenance operations that would have been cancelled because of weather __

h) Provide better information service to the public __

i) Other __

36 (If any yes's above, ask)
For each of the instances you just mentioned, can you estimate the operating cost impact that resulted?

a) Reduce time spent patrolling

b) Avoid unnecessary plowing

c) Avoid unnecessary salting or sanding

d) Avoid failing to start plowing soon enough

e) Avoid failing to start salting soon enough

f) Avoid calling in office staff unnecessarily

g) Avoid planning general maintenance operations that would have been cancelled because of weather

h) Provide better information service to the public

37 Can you think of instances where using RWIS has resulted in increased costs for your patrol, or caused you to make a wrong decision?

38 What percentage of the times when you use RWIS, do you use it to make operational decisions?

39 Can you think of instances where you have made decisions based solely on RWIS information

Yes __ No __ DK/R __ (If yes, ask)

How often

What result

40 Has RWIS become a regular part of the decision making processes at your patrol?

Yes __ No __ DK/R __ (If yes, ask)

How

41 What effects does having RWIS at your patrol have on your contractors?

Reduce/increase standby times

Reduce expenditures on contractors

Let contractors improve their own scheduling

42 What uses does RWIS have for planning and managing operations during good weather?

43 What uses could RWIS have for planning and managing operations during summer?

44 If the RWIS terminal were combined with a computer, are there any applications that would improve the effectiveness or efficiency of your operations.

a) Inputting management reports

b) Keeping track of patrol budget

c) Scheduling personnel

d) Keeping track of inventory

e) Keeping track of contractors

f) Keeping track of general maintenance

g) Getting reports from HQ

h) Electronic mail